any. *Colour* porcellaneous. *Spire* very short, roundedly conical, subscalar from the cylindrical rise of the whorls out of the perpendicularly sunk sutural channel. *Apex* very blunt and rather large, impressed. *Whorls* 5, very short, except the last, which occupies nearly the whole shell, rounded above, cylindrical below in the channel of the *suture*, which is axially impressed. *Mouth* oblong, pointed and channelled above, slightly narrowed below. *Outer lip* thin, scarcely prominent or arched, running out to a blunt point in front to the right, whence it is obliquely truncated backwards to the point of the pillar with a deepish cut. *Inner lip*: there is on the body a very thick prominent and irregular pad of glaze, which curves round the straight point of the pillar and there is 4-plaited, and, with a sharply defined edge, encircles the point of the shell. H. 0·26. B. 0·13. Penultimate whorl, height 0·035. Mouth, height 0·19, breadth 0·07.

The low spire, very blunt apex, and four plaits on the pillar-pad distinguish this species from *O. rosalina*, Duclos, or *O. rufi-fasciata*, Reeve (which Dr. Kobelt holds as = *O. mutica*, Say), or *O. inconspicua*, C. B. Ad. It is perhaps most like *O. pusilla*, C. B. Ad., which it resembles in lowness of spire and angularity at suture; but the spire is even lower than in that species, and the body-whorl is more tumid.

On some Points in the Morphology of the Test of the Temnopleuridæ. By Prof. P. Martin Duncan, M.B. Lond., F.R.S.

[Read December 15, 1881.]

(Plate VIII.)

Contents:—I. Introductory Remarks on the Subfamily *Temnopleuridæ*. II. Morphology of the Pits of *Salmacis sulcata*, Agass. III. The Sutures of *Salmacis sulcata*. IV. The Morphology of the pits, sutural marginal grooves, and of the sutures of Adult *Temnopleurus toreumaticus*, Agass., and of the Young form. V. The Pits and Sutures of *Salmacis bicolor* and *Amblypneustes ovum*. VI. Remarks on the pits, sutural grooves, and sutures. VII. Classificatory Conclusions.

I. *Introductory Remarks on the* Temnopleuridæ.

Desor, in his 'Synopsis des Echinides Fossiles' (1858), divided his tribe of Latistellate Regular Echini into the Oligopores and Polypores; and he separated the Oligopores—that is to say, the Echini with three pairs of pores to each ambulacral plate—into

three types. The second type he made to comprehend the genus *Temnopleurus*, Agass., and its allies, they being Echini with sculptured tests and ornamented with fossettes, or little cavities, at the angles of the plates. Their pores might be unigeminate or bigeminate*. This type has been called a subfamily of the family Echinidæ by A. Agassiz†, and the name of Desor has been appended to it. It has received much attention from nearly every naturalist who has studied the Echinoidea, and especially because some of the genera have persisted from the commencement of the Tertiary ages to the present day.

There have been ten genera associated with the subfamily, some of which belong to it without doubt; and the classificatory position of the others has been debated or enlarged upon by Desor, Lütken, and A. Agassiz. These authors, and also L. Agassiz, E. Forbes, Jules Haime, D'Archiac, Lovén, and Bell, have contributed to our knowledge of the superficies of the test of many of the species of the subfamily.

During the last twelvemonth a very large collection of fossil Echinoidea from Sind has been entrusted to Mr. Sladen, F.L.S., and myself, by the Superintendent of the Geological Survey of India, for description; and amongst those specimens which had been derived from the Eocene rocks there were many which would be called Temnopleuridæ, and some forms which required very careful consideration before they could be classified therein—such, for instance, which had a ribbed ornamentation around the primary tubercles and extending across the median space of the interradials, the spaces between the ribs resembling those drawn by A. Agassiz in *Trigonocidaris*. But the spaces were not really, to my mind, either sutural impressions or little cavities at the angles of the plates. In fact, I found the classificatory difficulties great.

Wishing to have some definite information concerning the morphology of the cavities at the angles of the plates and the meaning of the sutural depressions, I sought for information in the writings of my predecessors, and obtained recent specimens from the southern coast of Sind. The desired information has been found exceedingly meagre. In fact, so far as I have been able to discover, no one has examined the deeper connexion of

* Desor, 'Syn. Ech. Foss.' p. 50.

† A. Agassiz, 'Revision of the Genera of Echini,' p. 460.

the pits (as the cavities at the angles of the plates are properly called), or has satisfactorily explained the nature of a sutural depression.

I was impressed that the classification would be rendered more satisfactory by a careful examination of the nature of the cavities or pits at the angles of the plates, and of the so-called sutural depressions or furrowings.

II. *Morphology of the Pits of* Salmacis sulcata.

In order to be exact, it is necessary to call the openings and cavities at the angles of plates "pits," and not pores. The suture of two adjoining plates is really the whole junction of their edges; so that the superficial line denoting this on the surface of the test should be called the margin of the suture.

Specimens of *Salmacis sulcata*, Agassiz, of many dimensions and ages were examined in the first instance.

On referring to the 'Revision of the Echini' by A. Agassiz (p. 471), in reference to the genus it is noticed, "angular pores at junction of plates." With regard to the specific diagnosis, it is stated that the sutural pores are slightly larger than those of the species *Salmacis bicolor*, Agass. On turning to the description of that species, it will be found stated, "The pores at the median junction are small, and the horizontal sutures of the coronal plates slightly furrowed." In other words, the pits are small and the margin of the suture is slightly furrowed.

On examining the specimens before and after fracture, it was evident that in *Salmacis sulcata* the pits at the angles of the sutures, in the median interradial and ambulacral areas, occupied what might have been the point of one plate and part of the line between the edges of the adjoining plates, and that at the junction of the tentaculiferous plates with the interradials there was a vertical series of pits also interfering with the perfect shape of the interradial plates. In fact, in some specimens the pits, as a whole, seem to interfere considerably with the continuity of the test, and would also seem to leave but little edge to some plates on which sutural junction could take place.

A Notice of the Nature of the Pits and Sutures of Salmacis sulcata, *Agass.*—The pits of the test of *Salmacis sulcata* are in the median lines of the ambulacral and interradial areas, and also at the junction of the interradial plates with the tentaculiferous

plates of the ambulacra. The external dimensions of the pits along the median lines are much smaller than and afford no indication of their inner development. These pits pass deeply into the test and enlarge within, especially actinally and abactinally, or in the vertical direction, and less so laterally.

In the interradial areas each pit leads to a compressed flask-shaped cavity with a broad bottom. It does not perforate the inner part of the test, but reaches inwards to within a very short distance of the inner part of the edge of the plates, where there is a layer of the usual reticulate, calcareous structure of the test.

Each pit occupies space in the edges of the approximated plates, and is surrounded, except superficially, by more or less projecting reticulate tissue, and is separated by it from the pits above and below on the same line (Plate VIII. fig. 3). In some instances the pits unite deeply with a neighbour; so that if the outline of the flat flask-shaped hollow were marked on the outside of the test, to show its relation in point of size to the opening of the pit, it would occupy an elliptical space three times the dimensions of the orifice. As each plate is in relation with three median pits, a considerable part of its edge is hollowed out, the surface of the test being undermined.

In the median line of the ambulacral areas the pits enlarge as they pass inwards, are deep, flat flask-shaped, elongate vertically, narrow from side to side, and frequently have a projection on their floor. They occupy less space than the interradial series, but undermine the plates close to their edges. It is perfectly evident that the interradial, as well as the ambulacral pits of the median lines are depressions on the faces of the opposed edges of adjoining plates (Plate VIII. figs. 3 & 8).

The small pits between the tentaculiferous ambulacral plates and the interradials pass inwards as cylindrical spaces ending in *cul de sacs*; some bend in their course, and others enlarge slightly (Plate VIII. figs. 6 & 7).

It is evident that in *Salmacis sulcata* the pits, which are of moderate dimensions at the surface of the test, occupy much more space within it. They are lined with a continuation of the ordinary derm of the outside of the test, and do not appear to contain any special structures. They sometimes communicate, within, with one another.

On examining one of the interradial plates, the apex of its angle, which is received between two corresponding interradials,

will be found to be blunt and even slightly concave; and this loss of substance is to accommodate the pit (Plate VIII. figs. 1 & 2, *a*, *b*). Opposite to this concavity is the horizontal suture between the associated interradials; and there is loss of test on their edges close to the commencement of the suture. The margins of the sutures, both vertical and horizontal in direction, are faintly grooved; and in large specimens there is a distinct shallow pit on the vertical series, between each larger pair of pits (fig. 2, *c*).

The shallow pit is a mere depression; yet it occupies what might have been solid test, and it diminishes the amount of plate-edge available for junction or suturing with its fellow.

The line of junction between the interradials and the tentaculiferous plates of the ambulacra is marked, not only by a pit at the commencement of the horizontal interradial suture, but also by four, and sometimes five, well-developed and deep pits at the junction of the sutures of the small ambulacral plates. Hence on the surface of the test the interradial area is attached to the ambulacral by a series of very small processes, across which a faint vertical sutural line can be seen.

III. *The Sutures of* Salmacis sulcata.

This development of the pits appears to relate to the very remarkable sutures of the species.

The sutures of the interradial plates are four in number. Each plate is joined by its abactinal edge to the plate above; by its actinal edge to the plate below: by a lateral median angular suture to the plate at its side; and by a lateral suture to the plates of the ambulacrum close by. The first two sutures are horizontal, and the others are more or less vertical in direction.

On carefully separating two interradial plates of a vertical series, along the horizontal suture, the tissue connecting their edges (that is to say, the suture) is seen. The abactinal edge of the lower plate is minutely, but very distinctly, marked with from two to four rows (from without inwards in the normal position of the test) of hollows or sockets. The rows are separate, and extend over the breadth of the edge not quite close to the ends. The sockets are limited, deep, and are special structures in the reticulate calcareous tissue of the plate (Plate VIII. fig. 5). The test is brilliantly white; and although the sockets can be seen with a hand-lens without difficulty, some careful arrangement of the light transmitted by the bull's-eye, or reflected from

the stage-reflector, is necessary. The specimen, fixed on wax, should be moved on its axis by the rotating-stage so as to cast shadows in different directions. This proceeding is especially necessary in carrying out some of the following observations.

On looking at the actinal edge of the interradial plate next in vertical succession to that just mentioned, it will be found to be covered with a considerable number of minute, well-defined, blunt, conical projections of the reticulate calcareous tissue of the test. These knobs can be seen from the outer surface of the plate, extending beyond it. They are in rows; and when the two plates are in accurate and normal contact, the knobs fit into the sockets of the lower plate (Plate VIII. fig. 4). The only place where this knob-and-socket arrangement is deficient is quite at the end of the edge of the plates, where the pit runs in for a short distance. Each interradial plate has a series of knobs on its actinal edge, and sockets on the abactinal edge.

The ambulacral areas are occupied by two vertical series of plates, separated by a zigzag vertical suture along the median line, and they are flanked by the numerous small, pored plates of the tentaculiferous series. Each large ambulacral plate has an actinal and abactinal horizontal edge, an angular suture uniting it with two neighbouring plates along the median line, and an opposite end, to which are attached the small plates of the poriferous zone. The abactinal edge of each of the large ambulacral plates is covered with minute knobs of the reticulate tissue, and its actinal edge has rows of sockets; so that the lower or actinal edge of one plate receives the knobs of the abactinal edge of the plate below, an arrangement exactly the reverse of that which exists in the interradial areas. The pits interfere but slightly with this arrangement, as they are almost out of the way and close to the outer angle.

The vertical sutures of both areas being in relation to the large pits of the median lines, are very different in their construction to those just noticed, and must be considered in detail.

First. The median zigzag suture of the interradial area, which unites the broad interradial plates side by side.

The edge of a plate in this position forms the sides of an angle; and, as before noticed, these large pits excavate its surface. Each expanded pit is separated from its neighbour on the same plate-edge by a projection, which is broad toward the outer surface of the plate and narrower inwards. There is also a shelf-like pro-

cess along the inner part of the edge, bounding the expanded part of the pit inwardly. There are knobs of reticulate tissue on alternate projections and sockets on the others. Moreover, on one projection along its broadest part is an elliptical shallow cavity, and on the next a convexity occurs in the corresponding position. Knobs are found on the shelf-like process in little groups, and then hollow sockets in groups, and so on. The knobs and sockets, grooves and convexities of one plate-edge correspond with sockets, knobs, convexities, and grooves in the edge of the opposed plate. These are the sutural structures; and they also limit the dimensions of the pits (Plate VIII. fig. 3).

A very similar series of structures is seen on the median angular edges of the ambulacral plates. The pits are separated by distinct pillars enlarging outwards, and merging inwards into a shelf-like structure, on which the pit ends inwardly. The knobs and sockets are on alternate pillars; and the enlargement of the one carries a long convex mass, and that of the other an elliptical cavity. Usually there is a projection at the bottom of each pit, from the shelf-like process. The knobs and sockets of one ambulacral plate fit into sockets and knobs on the edge of the opposite plate normally in contact, and act as sutural processes (Plate VIII. fig. 8).

Finally, there are sutures between each interradial plate and the small tentaculiferous plates of the ambulacra. The small pits are more or less in vertical series. On the interradial plate-edge, sections of the pits are seen separated by broad processes running inwards, and merging into a well-developed inner reticulate tissue. The processes and this tissue are studded with well-developed sockets (Plate VIII. fig. 6). But on the corresponding edges of the ambulacral plates the similar processes and inner shelf-like tissue are covered with knobs which stand out well (Plate VIII. fig. 7); these fit into the sockets of the corresponding interradial plate, and constitute the suture.

There is very slight and probably no absolute junction between any plates by continuity of reticulate tissue; but the suturing consists of these elaborately alternate systems of knobs and sockets, and of projections and corresponding grooves.

The breadth of one of the knobs is commonly $\frac{1}{300}$ inch, and the height is rather more. The sockets correspond in size.

IV. *The Morphology of the Pits, sutural marginal Grooves, and Sutures of* Temnopleurus toreumaticus, *Agass.*, 1841.

The pits of all the areas are very visible in this typical species of the genus *Temnopleurus* ; and there are marginal sutural grooves of a very distinct kind. The pits have a considerable inward oblique and vertical extension within the test ; their inner dimension varies according to position ; and they occupy depressions in the edges of adjoining plates.

At the ambitus especially the principal tubercle of each interradial plate, or a process of its scrobicule, comes close to the actinal edge and covers and obliterates, to a greater or less extent, the marginal grooving. So that when the plate is separated from the one below, or that which is placed orally to it, the base of the tubercle, or a prolongation of its subscrobicular structure, is seen to project into a concavity on the outer surface of this lower plate close to the abactinal sutural part.

This deep grooving of the sutural margin and of the superficies of the test close to it, coupled with the existence of the great primary tubercle with its basal structure, interferes with the thickness of the actinal and abactinal edge of the plates. The thickness is greatest in the central part of the edge, and thence there is a gradual thinning on either side. The actinal edge of each interradial plate is covered with numerous knobs, rounded at the end, and of the same character as those noticed in *Salmacis sulcata*. Sometimes the knobs are placed irregularly ; and in some places they are in lines, and then one knob runs into another, and a line of elevation is produced and is more or less continuous. On the abactinal edge of the plates there are sockets which correspond with the knobs and lines of elevation of the adjoining plate. (Plate VIII. figs. 10 & 11.)

In the ambulacral areas the median pits are deep, oblique, and not much expanded within. The grooving of the margin of the suture is very decided towards the median line, and less so towards the poriferous zone ; and, in the first place, the thickness of the plate is greatly reduced. Hence the outline of the horizontal sutural edges of the ambulacral plates is irregular. The actinal edge of each plate has numerous sockets, which receive the knobs of the abactinal edge of the plate below. Thus there is the same reversal of the direction of the knobs and sockets, with regard to those of the interradial areas, as was noticed in *Salmacis sul-*

cata. The tentaculiferous plates, or the poriferous parts of the ambulacral plates, have knobs and sockets arranged like those of the main plate.

On examining the edges of the interradial plates along the median line the succession of pits is very distinct. They enlarge, as has been stated already, slightly at their inner end in the vertical direction, and reach inwards very close to the inner margin of the edge. On either side of a pit, that is to say actinally and abactinally in vertical succession, there is a curved process passing from the inner part of the edge outwards, and then bending close to the outer part of the edge towards the angle of the plate (Plate VIII. fig. 12). These processes, two to each plate, enclose a space; and one of them has one series of sockets, and the other one series of knobs on it. The space is shallow and oblique, and is part of a pit. On the inner part of the edge, below the space and the end of the pit, there are groups of minute knobs and sockets. On the corresponding edge of the contiguous plate the same structures are found; but the position of the knobs and sockets is reversed, and there is a slight projection which fits partly into the space. The suturing is by the reception of the knobs by the sockets of the approximated plate-edges.

A similar arrangement occurs on the median edges of the plates of the ambulacral area; but there is more variation in the extent of the processes with knobs and sockets.

In parts of the test where the pits are unusually large, there is more than one series of processes, and a set of knobs and sockets bound the space or projection, as the case may be. On the other hand, near the peristome, where the pits are small, cylindrical, and yet pass far inwards, the suturing is by nearly straight lines of pits and sockets, which are parallel with the pits and are small.

The junction of the outer edge of the interradial plate with the poriferous plates of the ambulacrum is complicated by the presence of the pits at the end of the horizontal marginal grooves (actinal and abactinal), and by occasional pits at the junction of the sutural lines of the small plates with the interradial. But the suturing is by two to four processes, separated or not by pits, and passing from the inner part of the edge of the plate to the outer, just below the surface.

The processes consist of two laminæ of the reticulate tissue of the test; and between them are sockets in a series, or they may

run together and form linear depressions. The inner part of the edge internal to the base of the processes is crowded with sockets (Plate VIII. fig. 13).

Finally, the edge of the poriferous plates in contact with the interradial is marked by series of knobs which fit into the sockets in the corresponding interradial edge (Plate VIII. fig. 14).

The plates of the apical disk do not join the coronal and ambulacral plates by any knob-and-socket suture, but by a slight overlapping.

It is perfectly evident that the union of the edges of the plates of *Temnopleurus toreumaticus* and of *Salmacis sulcata* only differ in matters of slight detail. In both there is a reversal of the arrangement seen in the interradial area in the ambulacral; and in both the poriferous plates have knobs and join the interradial plates which are socketed.

Young Forms of Temnopleurus toreumaticus.—Several specimens of from $\frac{1}{3}$ to $\frac{1}{2}$ inch in diameter were examined. There are round, widely open shallow pits, the bottom of which can be seen from the surface of the test above the ambitus in both areas, and the marginal sutural grooving is slight. At the ambitus in some, but not in all, the pits and grooves diminish in size, and are often very small; and below the ambitus, in all, the pits of the ambulacral area are not so large as they are near the apex, and those of the interradials are very minute.

The edges of the interradial plates, along the vertical median line, show that the pits barely pass within the test near the peristome, and that they are deeper near the apical system; but they do not excavate the point of the angle of the plates. Where largest, they do not pass inwards more than in *Amblypneustes*. In fact, the flask-shape is not seen.

The suturing is different to that in the adult form; and it consists, where the pit is very insignificant, of well-developed rows of knobs, parallel with the outside of the test, or slightly irregular in their distribution, and of sockets arranged in similar order. The knobs are on one side of the pit and the sockets on the other; and they correspond with sockets and knobs on the opposed plates. Where the pits are larger and the sutural marginal groove is more pronounced, the knobs and sockets are in arcs, and frequently there are lines of knobs run together to form a linear elevation; and there are corresponding lines of depression. Here and there one of these lines has a distinctly inward track,

and passes from close to the outside of the test to the inner part of the edge.

The edge of the interradial plates in contact with the poriferous plates of the ambulacrum has two rows of large sockets parallel with the surface of the test. There are no other pits to be seen there, except those at the ends of the horizontal sutural margins between the interradial plates.

A more confused knob-and-socket arrangement is seen on the median edge of the ambulacral plates than on the corresponding edge of the interradials. But there is a general resemblance. The deepest pits are near the peristome; and on either side of them, on the edge of the plate, are confused nodules and depressions rather than well-defined knobs and sockets. Moreover, the running together of the knobs and sockets, respectively, in lines occurs, and the solitary lines passing from without inwards are visible. The deepest pits near the peristome, four or five in number, hold sphæridia of considerable dimensions.

The edge of the poriferous plates in contact with the interradium has two large rows of knobs; and here and there they run together to form rounded-off wedges. This arrangement is much more simple than in the adult form; and is seen less distinctly towards the apical part of the ambulacrum.

Finally, the actinal and abactinal edges of the interradial and ambulacral plates have a small number of knobs and sockets.

V. *The Pits and Sutures of* Salmacis bicolor *and* Amblypneustes ovum.

Salmacis bicolor.—The pits in this species are small externally; but they pass down far towards the inner part of the test, as cylindrical tubes (Plate VIII. figs. 15–17). A very considerable development of knobs and sockets is found on the median interambulacral and ambulacral plate-edges, and lines of more or less continuous depression and elevation also occur. The suturing is slighter than in the other species, but the knobs are often larger. The same kind of suture is found between the interradial plates and the ambulacral poriferous plates as in the species already mentioned. But the knob-and-socket suturing of the actinal and abactinal horizontal edges of the plates, coronal and ambulacral, although it exists, is slight and often difficult to see. Here and there it is replaced by linear elevated tracts and corresponding long depressions.

Amblypneustes ovum.—A small specimen of this species, in which the pits are mere depressions and barely pass inwards, was examined. There are traces of the peculiar suturing to be detected here and there; but a more bulky convexity enters an irregular concavity on the edges, in most parts. It is the faintest expression of the very marked structures of *Salmacis sulcata.*

VI. *Remarks on the Pits, Sutural Grooves, and Sutures.*

The pits are more than simple depressions of the marginal sutural lines; and when fully developed, as in *Salmacis sulcata* and *Temnopleurus toreumaticus*, they occupy space in the edges of contiguous plates and portions of the test at the angles. They commence, in the young form, as depressions on the sutural margin; and as the test increases in thickness the pit becomes deeper, not only from the outward growth of the test, but also from the inward growth and extension of the base of the cavity. Each pit is a hollow in the approximated edges of two joining plates, and some pits certainly communicate by their expanded bases. The pits undermine considerably, close to the edges of the test in some instances, and are lined with a continuation of the outer derm of the test. Lovén found sphæridia in those nearest the peristome in the median ambulacral areas; and I can testify to their occurring as high as the sixth pit in the young form. Elsewhere no special structures are in relation to the pits. Similar developments are not known in any other subfamily of the Echinoidea.

The groovings and depressions along the line of the sutures, so visible in *Temnopleurus*, and of much less significance in *Salmacis*, increase with the age of the individual in the first-mentioned genus; and it is evident that they add in the first genus to the extent of the superficies of the test. They may be broad or narrow, deep or shallow, and their continuity may be interfered with by vertical dissepiments or tubercles. They have an importance in the economy of the animal; and they may be slight, and yet the pits may be large. They are absolutely depressions between ridges on which tubercles are placed above the normal level of the plate, and which are ornamental elevations, as in *Temnechinus*, which has no true pits, and *Trigonocidaris.*

The sutures are composed of the ordinary reticulate transparent calcareous tissue of the test. The knobs are more or less hemi-

spherical; and their free surface is not one of fracture, but is perfect. Some are elongate, and others are elliptical and even very long at their base. The size varies in the species; and $\frac{1}{300}$ inch may be taken as a common diameter and height. The sockets are corresponding depressions in the edges of the plates; and their surface shows an even, unbroken, calcareous reticulation. They receive the knobs; and no derm passes down, from without inwards, in the line of suture to separate them. The processes on and between which the knobs and sockets are placed in adult forms, are boundaries of the sides of the pits; and I think that now and then there is continuity between the opposed processes of the two adjoining plates.

The number of the knobs and sockets is immense; and they are found on all the plates, which may amount to more than 1500 in a well-developed *Salmacis sulcata*. The test, as a whole, has no other bonds of union than these sutures; but the generative and ocular plates are not sutured with the others. When whole, the tests will stand considerable pressure; but when partly broken, they fall readily to pieces. The suturing is of a kind which is used in carpentry in making tables, and especially in uniting hollow spheres made up of pieces, when outer and inner bracing is not possible. It is called dowelling. I have not found this method of suturing in other genera; but irregularities of surface on the edges of plates are seen in some. Thus, in *Diadema setosum* there is a faint trace of an irregular suturing by processes.

VII. *Classificatory Conclusions.*

It would appear, from what has been written concerning the sutural depressions and pits, that it is not unreasonable to separate those Echinoidea with true pits from those which have only sutural grooves or depressions between raised ornamentation, and to consider the grooved forms, which are not pitted, more embryonic than the others.

The species which were described by MM. D'Archiac and Jules Haime from the Nummulitic rocks of Sind were placed by them under the genus *Temnopleurus*. But they have no true pits, only well-marked broad grooves over the margins of the sutures; and these grooves are really parts where the raised ornamentation of the test does not exist.

Desor states, in his 'Synopsis des Échinides,' p. 105, with reference to *Temnopleurus*:—"C'est par erreur aussi que M. Forbes prétend qu'il existe des pores aux angles des plaques coronales comme dans les *Salmacis*." Now typical *Temnopleuri* certainly have pits at the angles of the plates, and something more than deep sutural impressions there. Hence the Nummulitic forms are not true members of the genus *Temnopleurus*. The numerous members of the subfamily Temnopleuridæ which Mr. Sladen and myself are now describing from the lowest Nummulitic rocks have very decided rib-like ornamentation, and, of course, what are called grooves; but they are not pitted. So that all these Eocene forms from Sind must come under one or more genera with a raised rib-like ornamentation, without pits. They resemble in many points *Trigonocidaris*, Agass., and *Paradoxechinus*, Laube.

With regard to forms having pits, *Temnopleurus* is typical. The generic differentiation of *Salmacis sulcata* and a typical species of *Temnopleurus* is insufficient. *Amblypneustes* is approached through *Salmacis bicolor*. I do not think it possible to admit *Temnechinus maculatus*, A. Agass., amongst the Temnopleuridæ with pits until Agassiz has examined the sutures.

If the subfamily is to be rearranged according to these views, the oldest forms will form the group with depressions on the test in the line of the sutures, or, rather, with raised ribs.

The second group will consist of the genera *Temnopleurus*, *Salmacis*, and *Amblypneustes* and others with true pits.

It is interesting to note that the earlier forms of the Temnopleuridæ resemble the immature individuals of recent species, and that the immature individuals of *Temnopleurus toreumaticus* might be associated with some species of *Salmacis*.

DESCRIPTION OF PLATE VIII.

Fig. 1. *Salmacis sulcata*. Superficial view of the pits on the interradial median line. The sutural markings are distinct; and each pit transgresses on the substance of the angle of a plate especially. Magnified.

Fig. 2. An older specimen. The sutural marginal lines are more distinct. The pits are about the same size as in fig. 1; but there are depressions or semi-pits on the vertical sutures between the others *a* and *b*

are pits in relation to the angles of plate; *c* are the semi-pits. Magnified.

Fig. 3. The edge of an interradial plate along the vertical or median series of sutures. *a* and *b* are the parts of the pits pertaining to the plate, the rest being in the adjoining interradial. *c* is the semi-pit. The great development of the pits below the surface is seen; and they are separated by projections of the plate's edge, broad above, narrow below. These projections carry the sockets and knobs of the suture. Below *c* there is a long socket followed by three pits; and below the large tubercle a long projection is seen, and below it more knobs. Beneath the expansion of the pits, on the reticulate tissue of the test, are some knobs and sockets. Magnified.

Fig. 4. The actinal edge of the same plate. A series of knobs projects. Magnified.

Fig. 5. The aboral edge of an interradial plate, showing three or more irregular rows of sockets. Magnified.

Fig. 6. View along the line of suture of the ambulacral tentaculiferous plate and the interradial plate; the edge of the ambulacral plates is drawn. The deep and narrow pits (in section), some expanding, are shown; and between them are numerous knobs. These fit into the sockets in the interradial plate (fig. 7). Magnified.

Fig. 7. An interradial plate, ambulacral edge: the portions of pits correspond with others on the ambulacral edge, the raised lines between the pits carry sockets. Magnified.

Fig. 8. View of the edge of a median ambulacral plate along the line of vertical suture. The pits are large, and they extend on the edge of the plates They are separated by ridges, some knobbed and others with sockets. A process arises on the floor of the pit which is sutural. Magnified.

Fig. 9. An ambulacral series from within the test. The tentaculiferous pores are seen, and on the edge a number of minute knobs. Magnified.

Fig. 10. Abactinal edge of a coronal plate of *Temnopleurus toreumaticus*, showing sockets, some in linear series. Magnified.

Fig. 11. An actinal edge of an interradial plate near the apical system, showing knobs. Magnified.

Fig. 12. The median interradial suture and pits. Magnified.

Fig. 13. The suture and pits of the interradial plates adjoining an ambulacral area: sockets and pits. Magnified.

Fig. 14. Knobs on the ambulacral plate-edges in relation with sockets on the corresponding interradials. Pits are shown. Magnified.

Figs. 15–17. *Salmacis bicolor*. The median interradial suture, showing pits and knobs, sockets, elevations, and depressions. Magnified.

Mollusca of H.M.S. 'Challenger' Expedition.—Part XIII.

By the Rev. R. Boog Watson, B.A., F.R.S.E., F.L.S.

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[Read March 16, 1882.]

Fam. Buccinidæ, *Flem.*

Buccinum, *L.*	Nassa, *Lam.*
Phos, *Montf.*	

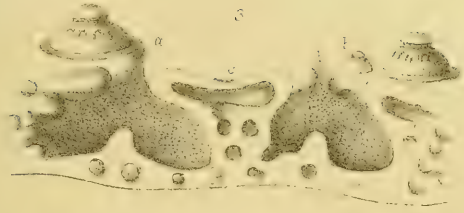
Buccinum, *L.*

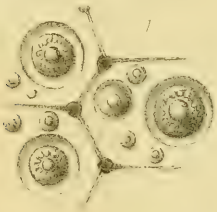
1. *B. albozonatum*, n. sp. | 2. *B. aquilarum*, n. sp.

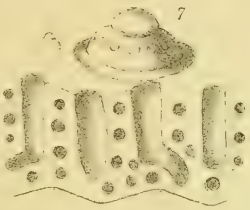
1. Buccinum albozonatum, n. sp.

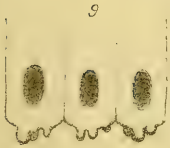
St. 155 d. Jan. 20, 1874. Lat. 49° 28′ S., long. 70° 13′ E. Royal Sound, Kerguelen. 28 fms. Mud.

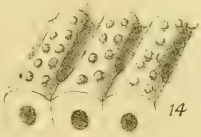
Shell.—Small, thin, fusiform, with a high spire, a short base, and a small snout, of a ruddy brown, tipped and banded with white; it has spiral threads. *Sculpture*. Longitudinals—on the earlier whorls there are some feeble folds below the suture; only sharpish hair-like lines of growth elsewhere. Spirals—over the whole surface there are flat threads with furrows of equal breadth between them: of these, on the penultimate whorl there are about 10; on the snout they are finer and closer. *Colour* muddy brown, with a transparent white-tipped pillar and central band on each whorl. *Spire* high, rather narrow. *Apex* blunt, rounded, with a slightly immersed tip. *Whorls* 6, regularly convex; the last contracts slowly on the base, and is produced into a short, one-sided, slightly expanded, truncated snout. *Suture* rather deeply impressed. *Mouth* largish, oval, open, straight, bluntly pointed above, pro-

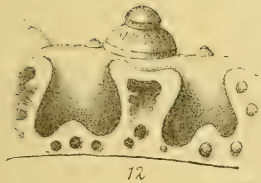


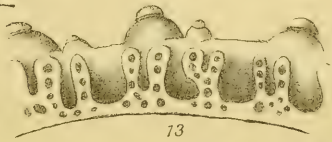


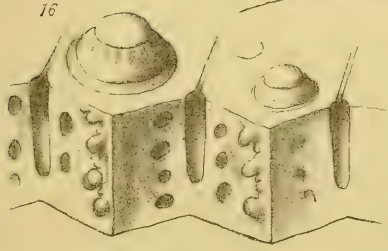


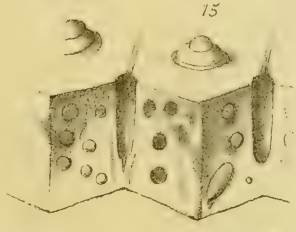












Berjeau lith. Hanhart imp

STRUCTURE OF THE TEST OF TEMNOPLEURIDAE.